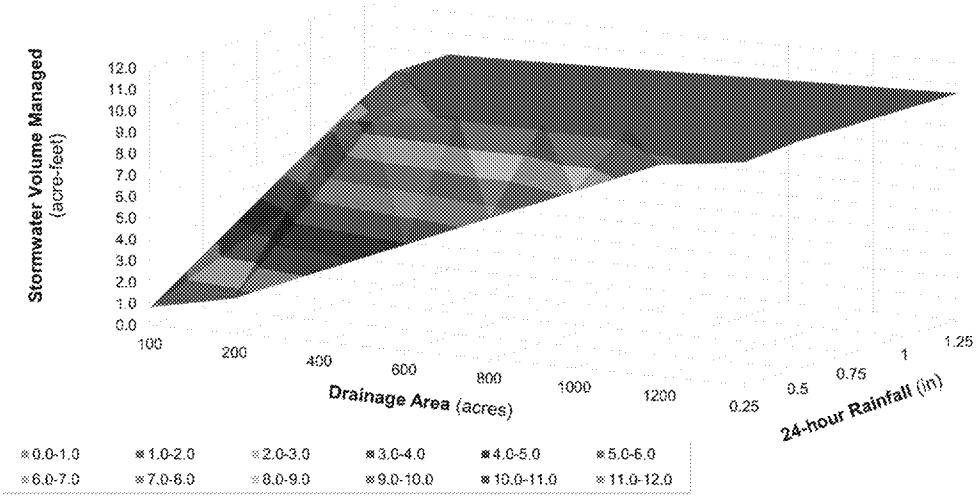
A Tool to Support Quantitative Evaluation of the Benefits of Stormwater Capture Projects in California

Background

In recent years, California municipalities have embarked on new planning initiatives that have emphasized the implementation of capital projects that capture, treat, infiltrate, or reuse stormwater as a resource. Some of these planning efforts have stemmed from new MS4 Permits (e.g., Los Angeles County, San Francisco Region, San Diego Region, Central Coast Region) that require or incentivize the development of comprehensive stormwater management plans and define the projects needed over time to meet water quality improvement goals (e.g., WQBELs, TMDLs). Similarly, to address Senate Bill 985, municipalities can develop Storm Water Resource Plans (SWRPs) to define stormwater capture projects that provide multiple benefits in terms of improving water quality or providing flood control, water reuse, habitat enhancement, etc. Projects included in the SWRP are eligible for Proposition 1 grant funding. Central to these planning efforts is the quantification and documentation of the amount of stormwater that can be captured and/or treated by the projects, often referred to as the amount of stormwater that can be "managed".

As plans are completed and municipalities transition to project implementation, tools can support efforts to track project benefits and cumulative progress towards meeting stormwater volume management goals established in the plans. Managed volumes have also become a common "currency" in some cases, providing a linkage between stormwater and water supply agencies, between upstream and downstream jurisdictions, and between jurisdictions who are collaborating on regional capture projects. However, while simple in concept, there are multiple variables in stormwater volume calculations, including the project type, location, capacity, underlying soil type, imperviousness of the project capture area, and more. The figure below shows the results of continuous simulation, demonstrating how the performance of a same-sized project can vary over an order of magnitude depending on the upstream capture area of the project and rainfall amount. In addition, there is often more than a one "storm" of interest; for example, while TMDLs and MS4 permits often emphasize a 24-hour duration storm (e.g., the 85th percentile, 24-hour storm), water supply agencies often focus on the average annual year. For SWRPs, the State Water Resource Control Board's guidelines recommends the use of the 85th percentile 24-hour storm event to evaluate the stormwater volumes managed by projects. During reporting and tracking efforts, stormwater agencies do not have clear methodologies or tools to calculate managed volumes for their built or planned projects. In some cases, municipalities do not have means to present their inventory of stormwater projects other than paper maps or PDFs.



The Need for a Statewide Tool

As municipalities begin the implementation of plans and associated stormwater capture projects, they are faced with the challenge of developing quantitative approaches to estimating stormwater volumes managed

by projects. In practice, this has led many agencies to use coarse calculations that are inaccurate (e.g., simply assume the project fills up 12 times per year) and do not account for the key project performance variables such as captured area (a project with a small drainage area will capture less water) or soil type. As the stormwater management plans and SWRPs advance, it would be ideal if the tracking of implementation progress relies on similar models as were used during plan development (rather than using completely different estimation methods). However, municipal staff often do not have the capability to run models, particularly continuous simulation models that are commonly used for reasonable assurance analyses, requiring reliance on consultants to perform modeling of project benefits. As such, agencies are faced with using coarse estimates that do not align with the methods used during plan development, repeatedly hiring consultants to perform rigorous calculations, or creating their own tools for progress reporting/estimation of stormwater volume managed by their projects.

There is a growing need for a statewide tool to assist municipalities with the estimation of stormwater volumes captured and managed for an array of capital stormwater projects. With recent advances in web-based technology, cloud storage capability, access to climate and land characteristic data utilized by models, open source data visualization libraries, and more we are now at a point when a publicly-available web-based tool can be effectively developed to meet the following goals:

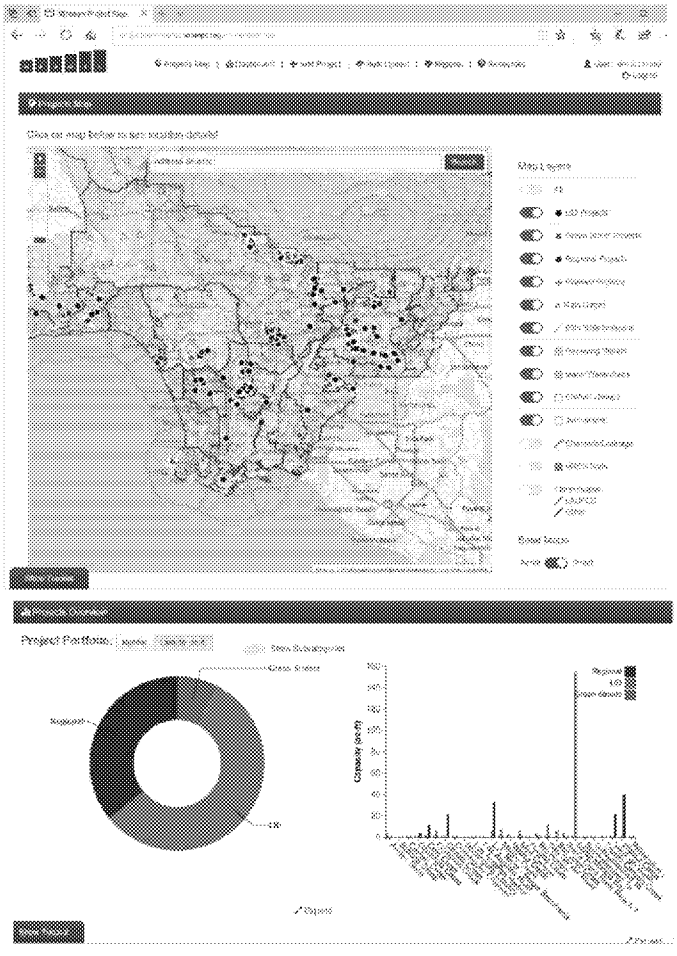
- Provide a free and user-friendly framework for municipal staff to create interactive inventories of their stormwater projects, leverage models to estimate cumulative stormwater management of their system, and visualize results for communication to the public and tracking of progress toward goals.
- Utilize publicly-available climate and land characteristic data to support simulation of stormwater runoff within any project drainage area in California, including calculation of inflow hydrographs and volumes for multiple time periods (e.g., average annual volume,) or design storms (e.g., 85th percentile 24-hr storm).
- Simulate project performance and the capture, infiltration, or treatment of stormwater for a wide variety of project types, locations, sizes, configurations, etc. Design characteristics that could be input by the user to generate managed stormwater estimates can include the type of project (e.g., regional underground infiltration gallery, green street, onside Low Impact Development), surface area, depth, underdrain design features, soil infiltration rate, and other considerations that can influence project performance.

The major benefit of a statewide tool would be the ability to standardize procedures for estimating project benefits. For instance, each of the processes above can be fully documented and vetted through a peer review process. Based on the peer-reviewed approaches, municipalities, regulators, and stakeholders can then have shared confidence that the tool provides a reasonable and defensible estimate of the benefits of a project in terms of managed stormwater volumes. Also, with stormwater management plans, SWRPs, and other plans (e.g., IRWMPs) using a similar tool to calculate these stormwater volumes managed, the resulting metrics have an increasing likelihood to be used as a common currency for shared goals, trading, and the assessment of benefits associated with financial planning and funding of stormwater projects relative to other water-related projects.

Example Web-Based Tool based on Public Domain Modeling

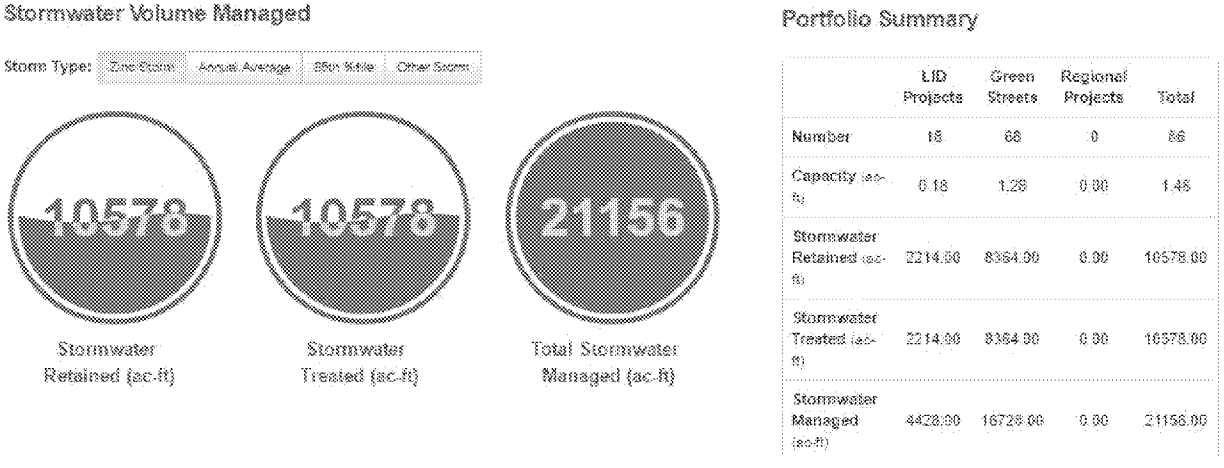
The Watershed Reporting Adaptive Management & Planning System (WRAMPS) was developed for the Los Angeles County Flood Control District (LACFCD) by Paradigm Environmental to support the tracking of stormwater capture by implemented projects and to streamline the production of annual reports for 86 jurisdictions in Los Angeles County. WRAMPS is a customized web application that uses public domain modeling and open source visualization libraries to generate interactive MS4 inventories and quantify the capture of thousands of projects across a wide variety of climates (from the beach to the mountains). Through development of WRAMPS, the LACFCD provided jurisdictions in LA County with an easy-to-use, interactive tool for building MS4 inventories and performing complex calculations with a few clicks. The system has become an integral part of annual MS4 reporting including tracking of progress toward Watershed Management Program (WMP) milestones and stormwater capture estimates required

by the Permit's Monitoring and Reporting Program. The figure to the right shows an excerpt from the WRAMPS dashboard for a single municipal program in Los Angeles County.



Example WRAMPS mapping and tracking visualization tools

WRAMPS is a web-based tool that includes customized pages to allow users to enter information for LID projects (either developer-built or municipal retrofits), green streets, and regional facilities (e.g., infiltration basins). WRAMPS includes mapping capability to display projects along with key GIS layers such as watershed boundaries, etc. The tool provides linkages to models (LSPC and SUSTAIN) that were used for a majority of the WMPs in the region. LACFCD tailored WRAMPS to provide modeling of stormwater volumes managed for each stormwater project and provide overall tracking of progress (within each municipal jurisdiction and watershed) towards achieving goals set by the RAA to meet TMDL wasteload allocations. WRAMPS includes "dashboards" that provide a summary of an individual agency "portfolio" of various categories of implemented projects and their combined storage capacities and managed areas, and simulation of various design storms for calculation of stormwater volumes managed (e.g., annual average volume, 85th percentile storm volume, bacteria storms based on allowable exceedance days, etc.). The graphic below from a dashboard provides a snapshot of stormwater management progress relative to metrics set by the WMPs. WRAMPS also provides the ability to output tables (Microsoft [MS] Word, Portable Document Format [PDF]) that provide more-detailed summaries of progress that can be attached to annual reports for the RWQCB. LACFCD is currently working on an additional WRAMPS module that will quantify the multiple benefits of stormwater projects in the Unincorporated Area and also provide real-time stormwater capture estimates.



	LID Projects	Green Streets	Regional Projects	Total
Number	18	68	0	86
Capacity (ac-ft)	0.18	1.28	0.00	1.46
Stormwater Retained (ac-ft)	2214.00	8364.00	0.00	10578.00
Stormwater Treated (ac-ft)	2214.00	8364.00	0.00	10578.00
Stormwater Managed (ac-ft)	4428.00	16728.00	0.00	21156.00

Element of WRAMPS "dashboard" summarizing stormwater volume metrics for implemented projects.

Considerations for a Statewide Tool

The example WRAMPS system in LA County provides a proof-of-concept for a web-based tool that creates an interactive MS4 inventory and generates reasonable and defensible calculations of the benefits of the stormwater capture projects. For a development of a similar system accessible by users throughout California, the following provides technical considerations based on lessons learned from WRAMPS:

- **Key Base Data Layers:** the publicly-available datasets for climate, soils, imperviousness, land use and more can serve as a powerful foundation for generating stormwater capture estimates, and the domain of many layers has become statewide, making a statewide tool feasible.
- **Free and Open Source Software (FOSS)**: A statewide tool can be designed to use free and open source software which has many benefits over closed source or third-party commercial-off-the-shelf (COTS) solutions. Open source frameworks free the end-user from dependence on an external entity that controls the future direction of the software's use, which can impose licensing fees, require reliance on closed source data formats, and force system upgrades at inconvenient times.
- **User Access**: Web-based tools have the unique advantage over desktop tools for controlling user access by defining which users have access to different types of data. Since web applications are hosted at a single location, user access can be controlled via user authentication and authorization. Multiple users may access the system at the same time with varying levels of permissions. There is the possibility of broadcasting some elements of the MS4 data to the public, while keeping other data behind private logins.
- **System Maintainability**: Web-based tools streamline maintenance since they are hosted on a web server and have only one point of access. There are a wide variety of options for hosting, from using local servers to cloud-based servers.
- **Repeatable Estimates**: Consistency across data and calculations plays a vital role for tracking and reporting of stormwater project implementation to regulators and stakeholders. A web-based tool could ensure consistency across calculations for different storms and by different users, which significantly increases confidence in the output produced for reports.
- **Ability to Leverage Continuous Simulation Models**: it is possible within the backend of web-based applications to leverage complex continuous simulation models, which allows for highly robust calculations with a few simple clicks.
- **User Experience**: only tools that are simple, easy-to-use and aesthetically pleasing will be long-lasting. Through dynamic frontends and interactive open source visualization libraries, it is possible to make stormwater estimates and tracking fun!